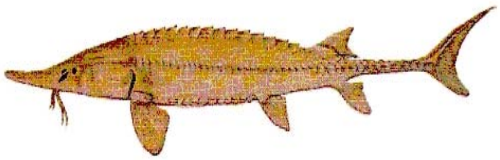
Mapping Potential Lake Sturgeon Habitat in the Lower Bad River Complex



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Abstract

To assist in identifying potential lake sturgeon (*Acipenser fulvescens*) habitat in the lower Bad River complex, we used a digital sonar system combined with a global positioning system to provide georeferenced data, and specialized sonar, bottom typing, GIS and statistical software to acoustically map bottom substrate types, locations and bathymetry. Ground truth data were developed from both petite Ponar bottom samples and associated acoustic data which were processed with bottom typing software. These data were used to produce substrate models in statistical software with a recursive partitioning method. Models were applied to survey data to classify it into substrate categories. Data were imported into GIS software to produce substrate maps. The lower Bad River had clay predominating at 45.82% (30.01 ha) of the total area (65.49 ha), followed by sand/clay at 32.07% (21.00 ha) and sand at 22.11% (14.48 ha). The open lake portion had sand/silt predominating at 75.74% (575.09 ha) of the total area (759.30 ha), followed by sand at 19.94% (151.40 ha), coarse sand/ medium pebbles at 2.33% (17.73 ha), clay at 1.94% (14.70 ha), and cobble /boulder at 0.05% (0.38 ha).

Key Words: lake sturgeon habitat, sonar, bottom substrate mapping, bathymetry, GIS

Introduction

Lake sturgeon (*Acipenser fulvescens*) is a species of concern in the Great Lakes region. Once abundant throughout the Great Lakes basin, lake sturgeon populations began to decline dramatically in the 1860's first from over harvest and later from man-induced environmental changes such as dams and pollution. The Bad River supports one of only two self-sustaining spawning populations remaining in the U.S. waters of Lake Superior. Running through the Bad River reservation of the Lake Superior Chippewa Tribe, the Bad River and its tributaries drain approximately 1,554,000 ha of land and provide more than 629 km of cold and cool water habitat. The most valued fisheries are for walleye (*Sander vitreum)* and lake sturgeon, with the river supporting spawning runs of both species (Elias 2001).

In the summer of 2000, the Great Lakes Trust Fund (GLTF) held a workshop to determine the assessment and research needs to restore lake sturgeon in the Great Lakes. Workshop participants identified as research priorities a need to sufficiently understand habitat constraints on the lifecycle of lake sturgeon and its role in regulating lake sturgeon population structure. To address information needs, the GLTF recommended studying the habitat requirements of all life stages of lake sturgeon in an individual system. The Bad River Band of the Lake Superior Chippewa, the U.S. Fish and Wildlife Service-Ashland FRO (USFWS) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) recommended the Bad River serve as a model river to begin answering research priorities. A proposal for such a project under the USFWS administered 2002 Great Lakes Fish and Wildlife Restoration Act was submitted and awarded. This report summarizes our efforts using acoustic techniques to map the lower Bad River and adjacent Lake Superior (hereafter the lower Bad River complex) habitats.

A number of acoustic mapping studies have been conducted on the upper Great Lakes. Hydroacoustic methods were used to examine lake trout spawning reefs in Lake Michigan (Edsall et al. 1989) and in Lake Huron (Edsall et al. 1992). The United States Geological Survey's Lake Superior Biological Station has been instrumental in developing and applying acoustic techniques to map habitat for a number of species and locations, including lake trout spawning habitat in Minnesota's near shore waters of Lake Superior (Richards and Bonde 1999), larval sea lamprey habitat in Lake Superior's Batchawana Bay (Fodale et al. 2003), and lake whitefish spawning habitat in the De Tour area of upper Lake Huron (Cholwek et al. 2001). Since these previous studies were finalized, acoustic hardware and software, Global Positioning Systems (GPS) and Geographical Information Systems (GIS) technologies have all progressed at rapid rates. The goal of the current study was to integrate these advancements to develop maps of potential habitats delineated by substrates and bathymetry in the lower Bad River complex.

Objectives

- Map and quantify tributary and near shore habitat in the lower reaches of the Bad River.
- Survey juvenile lake sturgeon and develop a relational model of their habitat use. This objective was to be met with data previously collected by the USFWS.
- Provide habitat data that will contribute to more effective sea lamprey control.

Prior to this survey, detailed substrate maps of the lower Bad River complex, sufficient for identifying potential lake sturgeon habitats were nonexistent and only bathymetric point data existed. This survey was designed to provide a more complete understanding of the bottom characteristics (as determined by surficial substrate types, their quantities, locations and depths) to assist in identifying and quantifying potential lake sturgeon habitat. It is expected that this information can be used for a variety of other purposes.

Report Format

This report describes our effort to collect data during the fall of 2004 to develop a GIS database to generate accurate maps of substrate classes and bathymetry of the lower Bad River complex. The **Methods** describe how data were collected and processed. Survey results and a brief discussion of habitats available to lake sturgeon are presented in the **Results** and **Discussion**. The people who assisted this project are listed in the **Acknowledgments** section. Citations are in the **Literature Cited** section.

The accompanying CD-ROM contains a complete electronic copy of this report, the processed data suitable for importing into GIS, maps produced from this data, and GIS metadata files. Also included is the Power Point presentation of this study delivered at the March 2005 Upper Lakes Meeting held in Ypsilanti, Michigan, sponsored by the Great Lakes Fishery Commission.

Methods

Survey Design - The surveyed portion of the lower Bad River was 9.6 km in length (Figure 1) and extended roughly 0.8 km upriver from the White and Bad rivers confluence to the Bad River mouth at Lake Superior. Boat speed during the river survey averaged ≈ 4.2 km per hour (≈ 1.2 m per second). Depths surveyed ranged from 1 m to 10.8 m. From Government Landing (Figure 1) to the furthest point surveyed upriver, three transects were surveyed: one mid-river and one as close as feasible to each bank. From Government Landing to the Bad River mouth, five transects were surveyed: one mid-river, one as close as feasible to each bank, and one half way between each bank and the mid-river transect.

In Lake Superior, we established 32 parallel transects, oriented perpendicular to the shoreline. Initial transects were spaced at 200 m intervals and covered 1.6 km of shoreline on both sides of the Bad River mouth. Sampling occurred from roughly 100 m to 150 m from shore out to 2 km in the open lake. In the field, returning acoustic signals were strikingly homogenous, so we decided to survey fewer transects spaced further apart. With the influence of wind, transects were separated by roughly 225 m to 300 m. Boat speed averaged ≈ 8 km per hour (≈2.2 m per second). Depths along the lake transects ranged from 1.7 m to 18.3 m.

Instrumentation - A Biosonics DT-X digital hydroacoustic system (Biosonics, Inc., Seattle, Washington) was employed to map bottom substrates. Acoustic data were displayed, recorded and monitored in real time on a notebook computer with Biosonics Visual Acquisition software version 5.0.4. During the lower Bad River survey, we collected data by fast multiplexing a 120 kHz 6^0 transducer and a 208 kHz 10^0 transducer mounted on a tow fish 1.2 m in length. The tow fish was so deployed to keep the transducer faces at a depth of .25 m. Data were collected on both channels at one ping per second with a 0.4 ms pulse duration. Signals exceeding a - 80 decibel (dB) on-axis mark threshold were digitized and continually stored to a laptop computer. Only the120 kHz transducer was used for the Lake Superior survey. We previously collected information to classify lake substrates with this transducer during our spring 2004 lake wide forage fish cruise of Lake Superior. A differentially corrected Ashtec BR2G GPS receiver/antenna system provided survey positioning data with sub-meter accuracy. Geographical coordinates of vessel position were embedded in the acoustic data files.

Substrate Classification - To classify substrates of these areas we applied the RoxAnn method (Chivers et al. 1990) as described previously by Cholwek et al. (2000). The RoxAnn device measures E1 (first echo) and E2 (second echo) values as voltage readings across the echo sounder transducer leads. These correspond to the bottom roughness and hardness, respectively. The general approach is to collect E1 and E2 values at sites (i.e., ground truth sites) with known substrates to develop a classification model for prediction of substrates at unknown sites based upon measured E1 and E2 values. Measurements of E1 and E2 values generated by the Biosonics DT-X system were gathered from computer files with BioSonics

Visual Bottom Typing (VBT) software version 1.9. Parameters used to track bottom depths and measure E1 and E2 values during data playback in VBT are presented in Appendix A.

After completing the survey, the Bad River acoustic data echograms were examined with Echoview software version 3.10 (SonarData Pty Ltd., Tasmania, Australia). Sixteen ground truth sites were chosen based on their color-coded echograms indicating bottoms with unique substrates worthy of revisiting. We returned to these sites and collected E1 and E2 samples (an average of ten contiguous pings constituted a sample) while anchored to maintain a fixed boat position for 2 to 5 minutes. Simultaneous with the acoustic data collection, substrates were sampled with a petite Ponar dredge as close as feasible to the transducer (within the acoustic footprint or very near to it). The dredge samples were examined for grain diameter and classified to the geometric graduated scale for clastic sediments formulated by Wentworth (1922) and modified by Edsall et al (1992).

Research has shown E1 and E2 measurements can vary over contiguous pings even at a fixed site with a homogenous substrate. To account for this ping-to-ping variability, contiguous E1 and E2 samples are usually averaged over a small number of pings. Substrates were predicted after averaging 5 contiguous pings in the Bad River and 20 contiguous pings in Lake Superior. We chose to average 20 pings in the lake portion of this study because this number of samples had been averaged in the earlier development of the Lake Superior substrate classification model.

A statistical technique called recursive partitioning (i.e. decision tree analysis) was used to develop the substrate classification models. Equal numbers of averaged E1 and E2 pairs for each substrate type were plotted together using JMP 5.1 statistical software (SAS Institute, Inc., Cary, North Carolina). The recursive partitioning platform calculated mean E1 and E2 mean values for each substrate type, and the derived cutting values that most significantly separated the means based on examining the sums of squares, due to the mean differences. The plot was split into leaves (i.e. trees) and the probability of each substrate type in each leaf was calculated. The lower Bad River model was developed from 107 randomly selected ground truth data pairs of each substrate type and 100 randomly selected data pairs of each substrate type were held out to test the model. The classification model was then applied to predict substrate types based on measured E1 and E2 values along our survey path. An identical approach was used to classify the lake portion of our survey. The Lake Superior model was developed from twenty-five randomly selected ground truth data pairs (E1, E2) of each substrate type and twenty-five randomly selected data pairs of each substrate type were held out to test the model.

Development of GIS layers- The resultant point data for bathymetry and substrates were used to produce GIS layers. The respective classification models for both the open lake and lower portion of the Bad River were applied to the E1 and E2 pairs measured for each area, and substrates along each area's survey path were classified. This data was then imported into ArcGIS version 9.0 software (ESRI, Inc., Redlands, California). The point data were processed with the Spatial Analyst extension of ArcGIS to create surface grids of substrate types and bathymetry for both the river and open lake areas.

River survey GIS layers - River data points were filtered to omit duplicate locations prior to GIS analysis. River features were digitized off 1992 DOQs (Digital Orthographic Quadrangles) and select 2004 geo-referenced aerial photography containing all point data. Automated background point data were created every 5 m along Bad River polygons to facilitate spatial analysis of raster interpolation. Spatial analysis was performed on point data to create raster grids for both substrate and depth data. The ordinary Kriging method was used with a spherical semi-variogram model for the analysis of both substrate and depth data. A variable search radius was used for the sample points with a maximum distance of 35 m, twelve points were used for substrate and three points for depth. The substrate grid was re-classed to integer values and converted vector lines to produce polygon data for the three substrate classes. The total area of each substrate type for the lower Bad River was then calculated using the interpolated surface. Depth grids were processed at a 1 m pixel resolution and a 3 m pixel resolution. One meter interval contours were processed from the 3 m pixel resolution grid to produce smoother vector lines.

Lake survey GIS layers - Prior to GIS analysis, lake data points were filtered to omit duplicate locations. The lake shore features were digitized off 1992 DOQs and a150 m buffer of data points was created to define the analysis study area and contain all point data. Automated background point data were created every 10 m about the study area to facilitate spatial analysis of raster interpolation. Spatial analysis was performed on point data with the inverse distance weighting interpolation method, to create raster grids for both substrate and depth. For substrate, a power of four with a variable search radius of twenty-four points was applied. For depth, a power of two with a variable search radius of twelve points was applied. A 3 m pixel resolution substrate integer value grid was created and converted to vector lines to produce the five substrate classes. A 5 m pixel resolution grid was processed for depth to produce 1m interval contours. Analysis in GIS provided the total area of each substrate type for the open lake.

Results

Three of the sixteen river ground truth sites were eliminated due to either an inability to anchor the boat to maintain position or inconclusive Ponar grab results. After reviewing the remaining thirteen E1 and E2 ground truth data files and associated petite Ponar samples, we identified three categories of substrates in the lower Bad River Figure 2: A) clay (very densely packed with fine particles between 1/2048 mm to 1/256 mm diameters, B) sand (1/16 mm to 1/4 mm, and C) a mixture of sand and clay.

The 208 kHz transducer signals from the river survey provided the greatest contrast in E1 and E2 values over these substrate classes, so we did not process the 120 kHz signals further. From the E1 and E2 ground truth data for the three substrate categories, samples totaling 107 for each substrate type were used in the recursive partitioning statistical procedure, the results of which are shown in Figure 3. The plot was split into four leaves and the proportion of each substrate type in each leaf is displayed. After testing, this model was used to predict substrates (based on the highest probability) at Bad River locations with measured E1 and E2 values. The model classification success (Table 1) was high for both clay and sand substrate categories (>90% of known substrates were classified correctly), but lower (42%) for the mixed sand/clay category.

A similar classification model (Figure 4) was developed for the 120 kHz 6^0 transducer from ground truth samples collected from fifteen sites around the perimeter of Lake Superior during the spring of 2004. Five substrate categories in the open water areas of Lake Superior were identified: clay (particles between 1/2048 mm and 1/256 mm diameter), sand/silt (1/256 mm to 1/8 mm), sand (1/16 mm to 1.5 mm), coarse sand/medium pebbles (0.5 mm to 10 mm) and cobble/boulder (64 mm to > 256 mm). The model classification success (Table 2) was 100% for clay and 72% for sand/silt and 70% for sand, 64% for coarse sand/pebbles and 84 % for cobbles/boulders. Other acoustic substrate mapping studies have found it more difficult to discriminate between harder substrate categories, and heterogeneous substrate categories versus homogeneous substrate categories (Cholwek et al. 2000 and Cholwek et al. 2001).

From GIS analysis of the classified and interpolated survey data, the lower Bad River had clay predominating at 45.82% (30.01 ha) of the total area (65.49 ha), followed by sand/clay at 32.07% (21.00 ha) and sand at 22.11% (14.48 ha). The open lake portion had sand/silt predominating at 75.74% (575.09 ha) of the total area (759.30 ha), followed by sand at 19.94% (151.40 ha), coarse sand/ medium pebbles at 2.33% (17.73 ha), clay at 1.94% (14.70 ha), and cobble /boulder at 0.05% (0.38 ha).

Examples of mapped bathymetric and substrate data for an area of the lower Bad River are shown in Figures 5 and 6, respectively. Lake Superior bathymetric and substrate GIS layers offshore of the Bad River mouth are presented in Figures 7 and 8, respectively.

Discussion

This survey produced a classified geo-referenced substrate and bathymetric point data set from which GIS layers were created. The distribution of substrates in the lower Bad River complex reflects both the area's geology, and the erosion, transport and deposition processes it is exposed to. The upland portion of the lower Bad River has lacustrine red clay banks extending from the bottom to just above the waterline and a considerable sandy soil overburden. Both contribute to the river's sediment load during higher water events. The inner bends of the river have lower velocities that allow sand to settle out, forming bars that extend out from the bank towards the mid-channel. The outer bends have increased water velocities, resulting in greater scouring, leaving only the underlying dense red clay and creating the greater depths of the river's thalweg. Backwater areas and depressions form catchments that collect fine substrates. In these areas sand/clay mixtures tend to predominate. Outside the river mouth in the open water of Lake Superior, long shore currents transport fine sediments consisting primarily of sand with some silt. A large, shallow (< 1 m in depth) sand bar exists a short distance from the mouth and runs parallel to the shoreline for some distance (see Figure 1). Cobbles/boulders were found in one small area on the lakeside of this sand bar in deeper water. Clay was found in sporadic, scattered patches through the shallower survey area and is likely an underlying material exposed by ice scour. The coarse sand/medium pebbles were nearly all found in the deepest areas farthest from shore.

Since the lower Bad River complex is an active and dynamic system subject to seasonal changes from storm events and ice scour, it is important to understand our survey results represent but a snapshot in time and may be subject to future change. However, over the near term, basic processes of erosion and deposition, parent materials and landscape features remain relatively constant and will likely maintain the substrate categories and bottom features found in our survey, albeit in possibly different locations and quantities over time. It might be important to resurvey the lower Bad River complex (or at least check each sample site with petite Ponar grabs) to coincide with future lake sturgeon sampling to insure it occurs on correctly identified substrate.

Peake (1999) demonstrated that hatchery reared juvenile lake sturgeon preferred sand substrate over the rougher and harder gravel and rock substrates in tanks, and this preference continued in larger adult lake sturgeon but was less pronounced. Peake (1999) did not study juvenile preferences for softer and smoother substrates like clay. Kempinger (1996) found that during the first summer of their life, age 0 lake sturgeon in the Wolf River, Wisconsin were captured on flat bottom with coarse sand and pea size pebbles in water with a detectable current and less than 0.75 m deep. They were never captured on fine detritus and the substrate was always devoid of rooted vegetation. Kempinger (1996) hypothesized that the age 0 lake sturgeon moved downstream into deeper water in the fall, but did not fall sample for sturgeon in these locations. Given that these studies suggest juvenile lake sturgeon prefer shallow depths with sandy bottoms it is likely the inner bends of the lower Bad River could be important habitat for them.

Although the driving force behind this project was to map potential lake sturgeon habitat, substrate maps might also indicate areas suitable for larval sea lamprey and this information may lend itself to more effective sea lamprey control. Schleen et al. (1996) reported the Bad River accounts for 20% to 30% of Lake Superior’s entire sea lamprey production. Sea lamprey larvae burrow in the river bottom. The clay/sand mixture category found in the lower Bad River complex is soft enough to burrow in and has a gelatinous consistency that can hold the shape of a burrow and could be inhabited by larval sea lamprey. Knowing the location of this sand/clay material could help effectively target larval sea lamprey habitats for treatment. However, it is not certain that larval sea lamprey make use of these substrates in the lower Bad River.

Other species are known to favor this sand/clay mixture, such as burrowing mayflies - *Hexegenia spp. (*a sturgeon prey item) and some native mussels. During our ground truth sampling with a petite Ponar, we collected several Eastern elliptio (*Elliptio complanata*) specimens (Figure 9) in a backwater area near the Bad River mouth (Figure 1) with a bottom comprised largely of this clay/sand substrate mixture. This mussel species has yellow perch as a known larval stage host, and is also thought to parasitize lake sturgeon.

Hydroacoustic survey methods we employed were quite rapid. The field survey and ground truth work took three people four working days. An additional work week was required to post process data to the point it was ready for importation into GIS. GIS data preparation, map production and analysis took one skilled GIS specialist two days. Report writing and figure preparation took one person seven days. Resurveying the lower Bad River would be even quicker since a substrate classification model now exists. This model can be used to rapidly find and verify areas of substrate for determining sampling sites for lake sturgeon (or other species).

This field data collection technique was not effective in waters less than 1 m in depth due to the transducer near field effect. For navigable rivers with depths greater than 1m, this method can readily be applied to classify and map bottom substrates. Since acoustic echograms are largely unaffected by turbidity, the methods we employed would be very effective in rivers with low visibility that prohibit visual bottom substrate typing.

The lower Bad River is known to contain both large and small woody debris which we did not include as a substrate category. Areas with large visible snags, logs or pilings were not navigable and not subject to our hydroacoustic survey. The three ground truth sites that failed to produce a petite Ponar sample could have been woody debris (or possibly some other material difficult to sample with this method). We attempted to identify this substrate with a drop video camera equipped with infra-red lights, but results were unsatisfactory. It is possible an additional or different light source may have improved the camera's performance. However, any improvement might be insufficient to distinguish substrate material due to the river's high turbidity, which would tend to back scatter any light source and thus prevent it from enhancing visibility. Woody debris, if located and found to possess unique acoustic properties, could easily be mapped after reclassifying the data set. Areas with large or small woody debris might be significant habitat for various lake sturgeon life stages, but are not represented in our survey.

Over the last several years, USFWS-Ashland FRO has sampled for lake sturgeon with bottom trawls in the Bad River. The study proposal called for using this georeferenced data set to develop a relational model of lake sturgeon habitat use. After completing the mapping work, we are convinced the fish samples were collected on too coarse of a scale to say much about specific habitat use. Now that GIS bathymetric and substrate layers have been finalized, we feel the stage has been set to characterize lake sturgeon habitat preference. Habitat use could be measured through a telemetry study and possibly a graduate student funded to carry out this research. The bathymetry and substrate layers can also be used to develop a stratified random bottom trawl survey design to better describe potentially important habitat(s).

Acknowledgements

This project was funded in 2002 by the USFWS administered Great Lakes Fish and Wildlife Restoration Act. Johnathon Pyatskowit (of the USFWS Ashland Fishery Resource Office) skillfully piloted the R/V Coaster during preliminary fieldwork in the fall of 2003. Lori Evrard of USGS did the same for one November day in 2003, all the surveying during the fall of 2004, and took the digital photographs used in Figures 2 and 8. E.J. Isaac (USGS) plotted the offshore transects in the Captain Voyager navigation software. Seth Moore (USGS) assisted one field day in 2003. Glen Miller (USFWS Ashland Fishery Resource Office) provided expert identification of the eastern elliptio mussels found during the survey. We thank Dr. Jason

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Table 1. Substrate Model Testing for Lower Bad River Ground Truth Sites

		Predicted Substrate Type Based on Measured E1 & E2 Values		
Actual Substrate Types	**No. of Samples**	**Clay**	**Sand/Clay**	**Sand**
Clay	100	92	5	3
Sand/Clay	100	28	42	30
Sand	100	0	10	90

Table 2. Substrate Model Testing for Open Lake Ground Truth Sites

		Predicted Substrate Type Based on Measured E1 & E2 Values				
Actual Substrate Types	**No. of Samples**	**Clay**	**Sand/Silt**	**Sand**	**Coarse Sand/Pebbles**	**Cobble/ Boulders**
Clay	25	25	0	0	0	0
Sand/Silt	25	0	18	7	0	0
Sand	25	0	0	19	5	1
Coarse Sand/Pebbles	25	0	0	0	16	9
Cobble/Boulders	25	0	0	0	4	21

Figure 1. A digitized USGS aerial photograph of the portion of the lower Bad River acoustically sampled (labeled with landmark locations).

A)

B)

C)

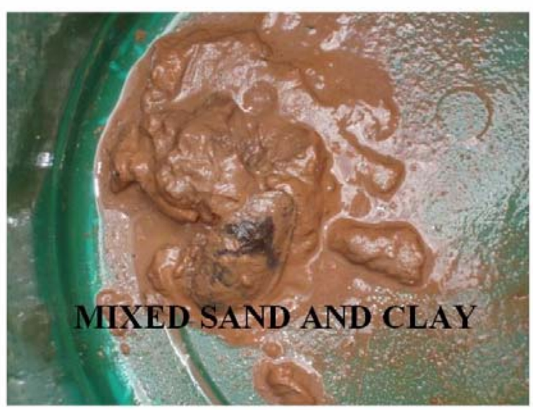

Figure 2. Photographs of the three substrate types encountered at ground truth sites: A) clay, B) sand, and C) a mixture of sand and clay. Photograph credits- Lori Evrard (USGS).

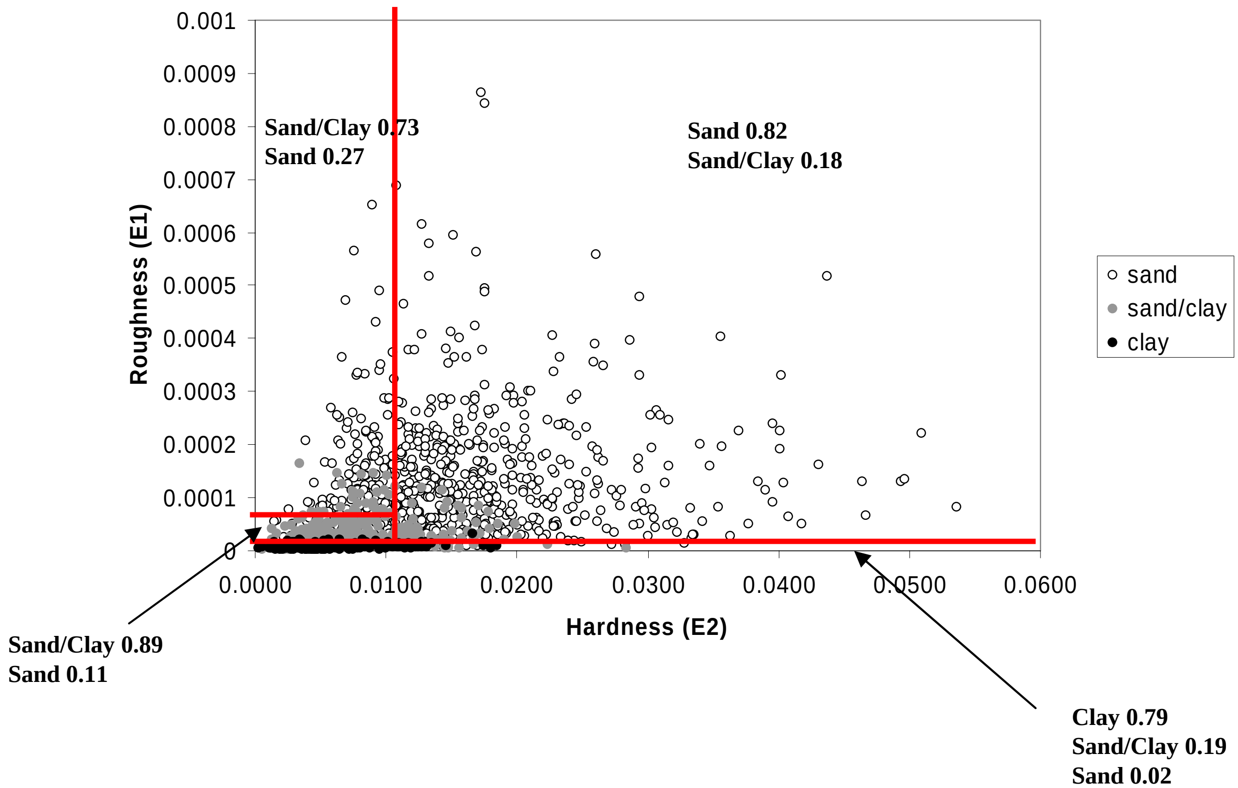

Figure 3. Classification model for lower Bad River substrates

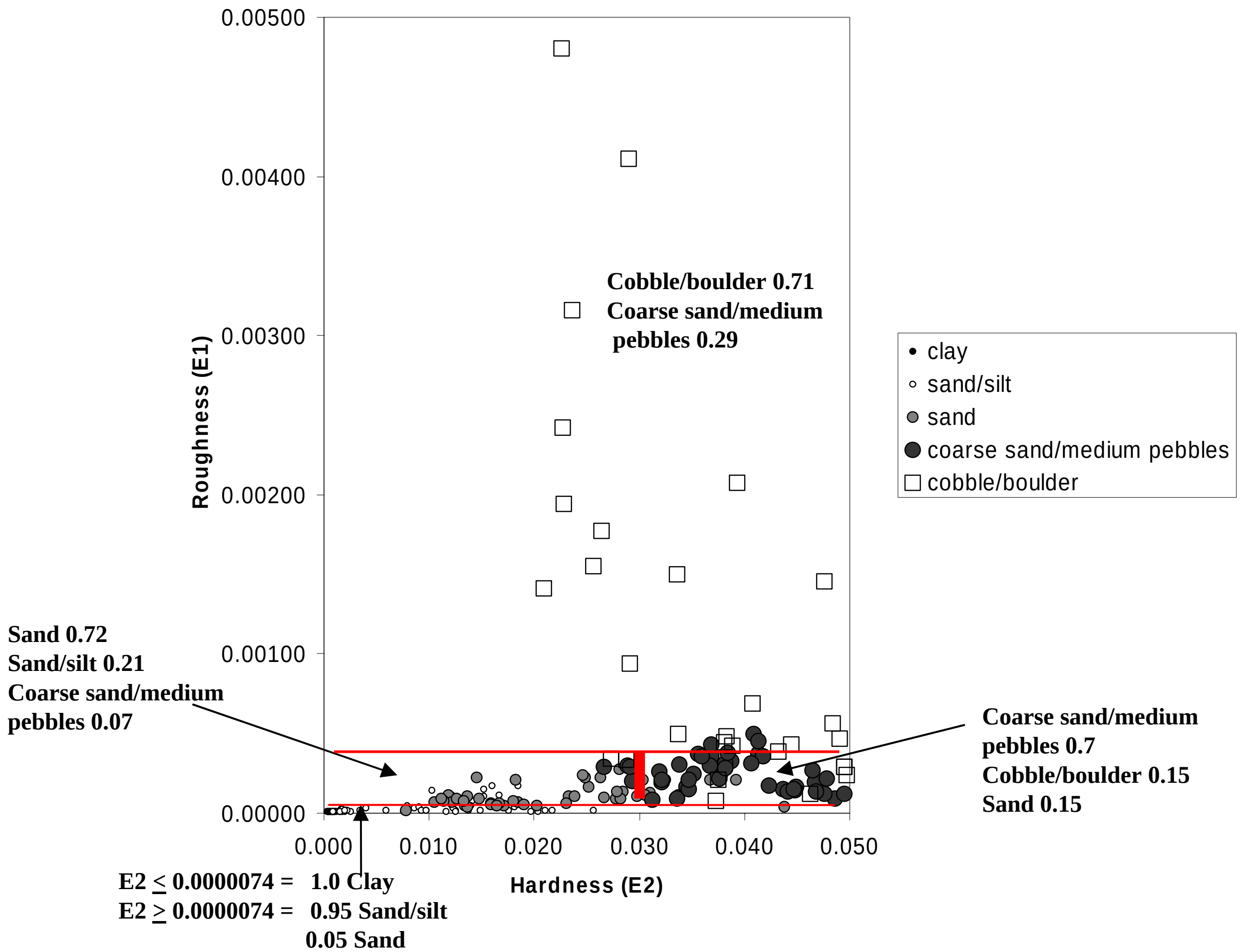

Figure 4. Classification model for Lake Superior substrates

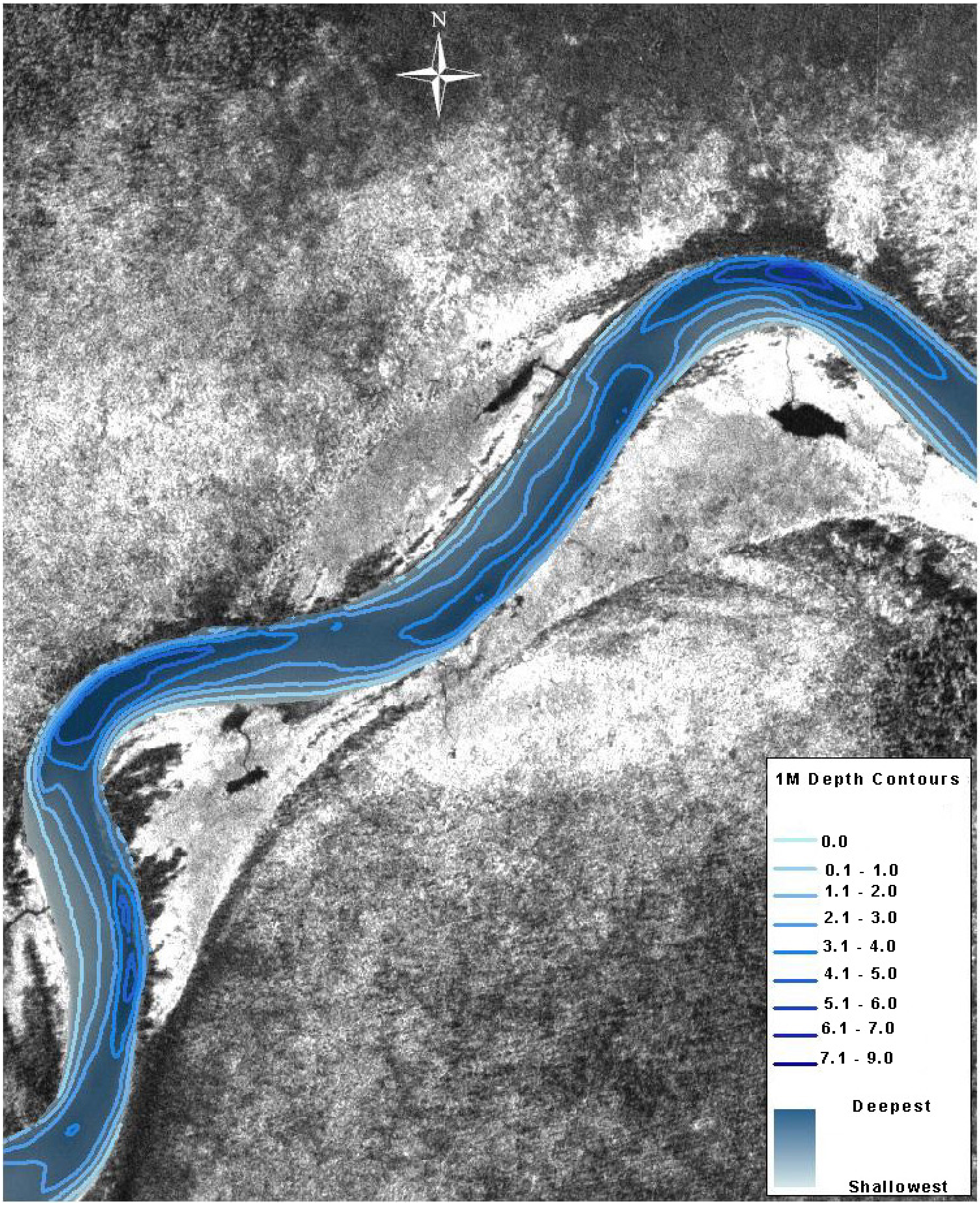

Figure 5. Example showing mapped bathymetry in the lower Bad River. Overlaid on DOQ (Digital Orthographic Quadrangle scanned from a digitized USGS aerial photograph of the area).

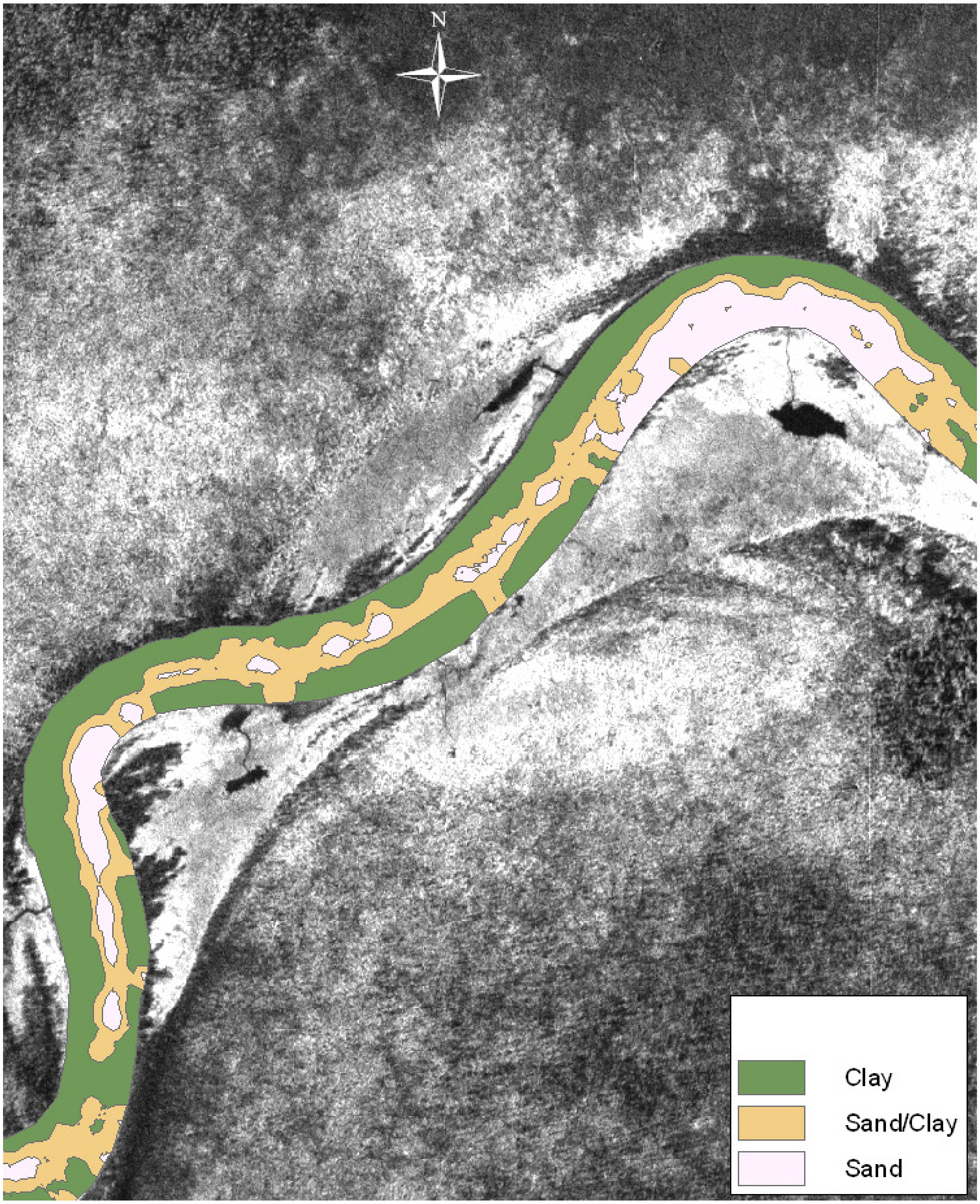

Figure 6. Example showing mapped substrate types in the lower Bad River. Overlaid on DOQ (Digital Orthographic Quadrangle scanned from a digitized USGS aerial photograph of the area).

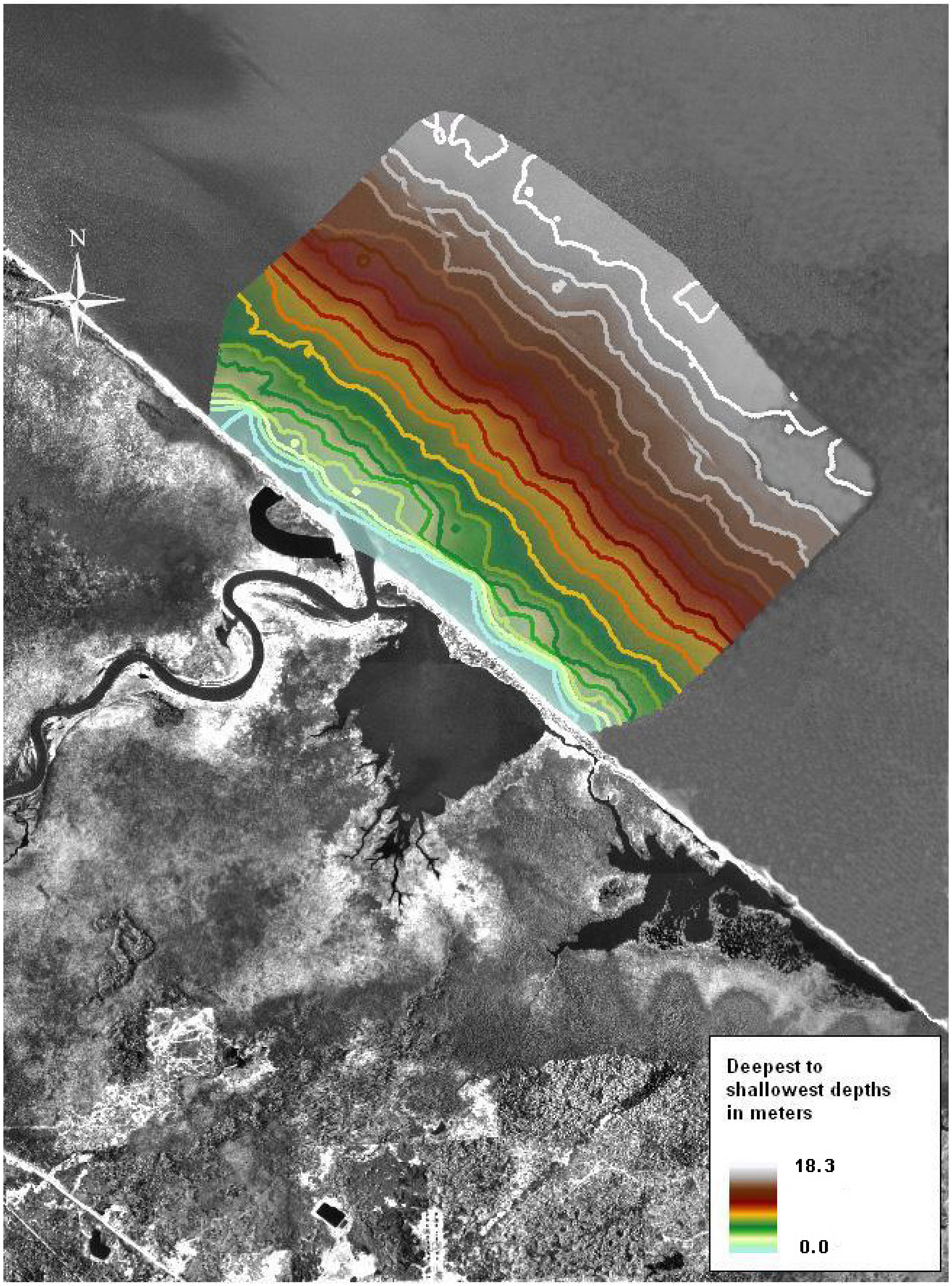

Figure 7. Example showing mapped bathymetry in Lake Superior near the Bad River mouth. Overlaid on DOQ (Digital Orthographic Quadrangles scanned from a digitized USGS aerial photograph of the area).

Figure 8. Example showing mapped substrate types in Lake Superior near the Bad River mouth. Data overlaid on DOQ (Digital Orthographic Quadrangles scanned from a digitized USGS aerial photograph of the area).

Figure 9. Eastern elliptio (*Elliptio complanata*) collected by petite Ponar grab in a backwater area near the Bad River mouth (see Figure 1 for location). Photograph credit- Lori Evrard (USGS).

Appendix A. VBT Post-processing Parameters

VBT Options	Lake Survey	River Survey
Bottom Window Settings		
First Bottom First Part	16 samples	16 samples
First Bottom Second Part	96 samples	48 samples
Sediment Window	96 samples	50 samples
Second Bottom Window	200 samples	96 samples
Pulse Length	16 samples	16 samples
Bottom Tracker Settings		
Peak Threshold	-52 dB	-45 and -60 dB*
Peak Width	5 samples	5 samples
Bottom Detection Threshold	-69 dB	-70 dB
Blanking Zone	1 sample	1 sample
Alarm Limit	8 samples	8 samples
Tracking Window	66 samples	66 samples
Pulse Width	16 samples	16 samples
Tracker Domain	20logR	20logR
Report Properties		
Pings in Report	5	20
Energy Percentage [%]	75	75

* A -60dB peak threshold was used to improve bottom tracking for selected shallow areas with softer substrates.